

*Extract of a Letter from Professor Secchi to Mr. Grant, F.R.A.S.**"Rome, May 8, 1852.*

"Allow me, dear Sir, to present you my most sincere thanks for the kind letter you addressed to me, and for the valuable present of your book, which was joined with it. I am very far from performing things worthy of the historical renown of our country; but I will try to make the best use of those means which are put at my disposition, although they are, indeed, very scanty: if in other times they were at the level of science, they are now decidedly below it. I hope, however, this state will not last long, and that some substantial improvement will be made to our observatory. The history which you have written is that of the most attractive part of the science, and which was wanted not only in England, but also in Italy, and I have no doubt it will be well received here. I would have written to you sooner, but I waited a little while, to be able to inform you of some researches which I have undertaken on the distribution of heat at the surface of the sun, and on the constitution of the lunar geology, which I hope will be well received by you.

"As to the first subject, you know that it is generally admitted that light is brighter at the centre of the solar disc than at the edges. M. Fizeau proved that the same diminution subsisted for chemical radiation, and I obtained a confirmation of it in the daguerreotypes of the sun taken during the last solar eclipse. But I had no proof that the fact would be the same with heat, although this was highly probable. I tried, therefore, to fill this blank, and have instituted a series of researches on the temperature of the different parts of the solar disc. I have been thus led to some interesting conclusions quite new to me; but before exposing them, I think it necessary to say something on the method of conducting the experiments. A thermo-electric pile, belonging to a very nice Melloni's apparatus, was attached to the telescope of our equatoreal, and fixed on the prolongation of its optical axis at a distance of about 15^{cm} from the eye-piece: the image of the sun, magnified by the eye-piece itself, was thus projected on the pile, and had a diameter of 12^{cm} nearly. When a leaf of white paper was put in the place of the pile, the image was perfectly defined, and the spots neatly terminated. By a diaphragm, the aperture of which was 4^{mm} broad, and 15^{mm} long, disposed parallel to the edge of the disc, a small portion of the sun's image, which was about 1' of arc broad, and 4' long, was allowed to radiate on the pile. The construction of the equatoreal enabled me to keep the same points of the disc steadily fixed on the pile, as far as it was necessary to obtain an invariable deflection of the needle of the galvanometer, and the position of the points of the sun, under examination, was readily deduced from the reading of the declination circle. There is no need to observe that all extraneous radiation was pre-

vented by large screens, supported by the telescope itself, and the turning dome was only opened as far as it was necessary to introduce solar rays on the object-glass. The telescope has 1^m.25 focal length, and 77^{mm} aperture.

“ Now these are the results obtained in sundry experiments :
 1. The heat of the solar image is at the centre almost twice as great as at the borders. This is found to be true, examining the diameters both in right ascension and declination ; 2. The maximum of temperature did not appear to be at the centre, but above it, in a point distant from it about 3' of geocentric declination. Constructing graphically the curve of the intensity of heat, taking as *abscissæ* the parts of the sun's diameter, and as *ordinatæ* the intensities themselves, it appears that this curve (a kind of inverted parabola) is not symmetrically disposed about the axis of the ordinates, but a good deal inclined towards the upper edge. I subjoin some numbers which represent the intensity of heat in the parts of the diameter of the sun taken in minutes, + above and — below the centre of the image.

Positions on the diameter of the sun in declination	+14'96	+11'32	+3'00	+1'32	—10'9	—14'88
Relative intensity of heat	57.39	88.81	100.00	99.48	81.32	54.34

These are the results of eight series of experiments, none of which is found in contradiction with the others, and their separate numbers are very nearly the same, so that the fact seems to me completely ascertained. It is certainly curious that the maximum of heat corresponds with the position of the solar equator, as visible from the earth at the epoch of the experiment (20th, 21st, 22d March). This leads naturally to the conclusion that the solar equatorial regions must be hotter than the polar regions, as was suspected already from the more frequent appearance of the spots there. The conclusion seems perfectly accurate, even admitting a solar atmosphere, since the effect of this last should be to diminish symmetrically the radiation around the centre of the image ; on the contrary, if the polar regions are less hot than the equatorial, the intensity of heat should have been less in the lower part of the image, where the south pole of the sun was visible ; and, consequently, the parts having equal distance from the centre of the image had a very different heliographical latitude, on account of the inclination of the solar axis to the ecliptic. From these principles only, the non-symmetry of the curve is accounted for. If *this alone* is the cause, the curve will be found symmetrical in the months of June and December, and reversed in September, since in the two former the equator passes through the centre of the image, and in the last is below it. But it is not impossible that the two solar hemispheres should possess different temperatures, as seems to be the case on the earth, and is suspected in *Mars*. If this is the case, these researches will throw some light on the climatology of the earth itself ; since the heat of the sun must be different, according as one or the other of its poles is turned towards the

earth. Future experiments will resolve this question. With respect to the poles of the sun, I shall add here a conjecture on a fact recently discovered by Captain Sabine. The journal *Institut* relates that this gentleman has found that the deviation of the magnet from its mean position at the Cape of Good Hope is found to be in opposite directions at the epochs of the two equinoxes. Might this not be an effect of the solar magnetical polarity on the terrestrial magnetism? The fact deserves to be examined, if it takes place in our hemisphere, and in opposite directions. Coming again to the solar heat, I have found that spots seemed less hot than the rest; but as only small groups of them were visible, no singular fact or law can be stated from these observations. I shall conclude this account by noticing an odd historical coincidence, namely, that these observations were made in the same room where it is said F. Scheiner, the first who used a telescope mounted equatorially, made his observations of the sun. This room has been this year added to the observatory.

“ I shall now briefly expose to you some considerations on the theory of lunar formations, which have been the subject of some discussions with our eminent geologist, Professor Ponzi, whom I gladly engaged in these researches. He is exceedingly well acquainted with the terrestrial volcanoes, both ancient and modern, (being now occupied in the description of the Roman States), and with Italian geology: the conclusions to which we have arrived are these.—The lunar volcanic formations must be distributed into three classes, to which a fourth class may be added analogous to our Plutonian formations.

“ The first class of the lunar volcanoes possesses a distinctive character; that the edges of the craters are almost completely obliterated, so that their border now is a continuation of the plane ground, in which they seem excavated, and a deep well only remains in the place of the ancient mouth of the volcano. Instances of this kind are very frequent near the south pole of the moon, and around the large spot Tycho; but Tycho itself does not belong to this class. The physiognomy of these craters nearly resembles our submarine volcanoes of the Monti Ciminii to the N.W. of Rome. The country around the craters of Bracciano, Bolsena, di Vico, is almost flat, and the old openings of the craters are now deep lakes. On this ground we are led to believe that even in the moon many subaqueous volcanoes existed. Another distinct character of these volcanoes of the first class is, that they are in a line, as if they burst from the cracks of the solid body of the crust produced by earlier formations: this is most striking in Arzachel, Purbach, Alphonsus, and many others, and they seem to follow the cracks made by the *soulèvement* which raised Tycho, the lunar Apennines, &c. Some of the higher chains of lunar mountains are seen visibly parallel to the alignment of the craters: this fact also is like that which we observe on the earth; indeed, the large Italian volcanic chain follows the line of the Apennines along this country.

“The second class of lunar volcanoes are those which have their outside edges elevated above the surrounding plane; their form is generally regular, and not broken, as those of the preceding class, and the ground around them is elevated in a radiating disposition, as is visible around Tycho, Copernicus, Aristotle, &c. The regularity of their forms suggests that the ejected matter was not disturbed by the motion of waves, and, consequently, that they were atmospherical volcanoes, like those of the Monti Laziali, Albani, and Tusculani, at the south-east of Rome; the want of breach in the craters seems to indicate that no lava, but only scorïæ and loose matters have been ejected. The disposition of the soil around them suggests the opinion that they are of a comparatively later epoch, and formed after the crust of the satellite was pretty resistant, and was capable of being elevated all round by a great effort. It is singular, indeed, that this *radiation* of the soil around is found proportional to the magnitude of the central crater. The effect of this *soulèvement* extended sometimes to a prodigious distance, comparable to that of the Cordilleras of the Andes on the earth. The greater part of the craters of both the classes now described possesses an insulated rock inside, very seldom appearing (at least in commonly good telescopes) perforated. This bears great analogy with what we see in more than one place in the ancient volcanoes of the earth, where the erupting mouth has been stopped by a dome of trachytic matter as by a stump. Monte Venere, near Rome, is of this formation, and lies in the centre of an immense old crater.

“The third class of lunar craters is very small, and bears a great likeness with those called by geologists adventitious craters, and seems to be of a very late formation, the last efforts of the expiring volcanic force. They are irregularly scattered through all the moon, but occur more frequently at the borders or inside of the old demolished craters, although not concentric with them, and seem to have been produced after the large ones were completely closed, either by trachytic ejection or by becoming lakes. These small craters have very seldom rocks inside, or a flat bottom; but their cavity is conical, and does not exceed in dimension our common volcanoes, which are yet active on the earth. From these facts and observations it appears, that volcanic action has gone on in the moon through all the same stages which it has gone and is going on in the earth, and is there, probably, completely extinguished, on account of the smaller mass of the moon, which has been cooled very rapidly. This rapidity of cooling, joined with the smaller gravity, may account for the great developement of volcanism there, and comparatively fewer Plutonian formations. But extensive instances of this kind are not wanting; the lunar Alps, the Apennines, the Riphææ, &c. may represent this formation, surrounding vast basins, and having modern volcanoes following the direction of the higher edges of their chains. Professor Ponzi seems to think it unquestionable that water existed at the surface of the moon; the fierce glare of the sunshine is not able to melt the ice there, which is, probably, at the temperature of the planetary spaces; just

as the sun at the surface of the earth is not able to melt our glaciers, which yet possess a certainly higher temperature. Cold, and other unknown causes, may have absorbed and fixed all the atmosphere which anciently existed, as we see that the immense atmosphere which anciently surrounded the earth has been fixed by several chemical processes and reduced to its actual composition; and it might be possible that this actually existing atmosphere of ours should be all solidified, either by cold or chemical processes, if the earth arrives at the same degree of cold which seems to have place on the moon.

“These are some of the conclusions to which we have arrived in our inquiry into the solar and lunar constitution; they do not certainly belong to astronomy strictly taken, but, a recreation from more serious occupations may be excused to astronomers dwelling in the pure climate of Italy. I trust you will receive them as a token of my gratitude, and of interest for the work which you have published.”

In a later letter Professor Secchi tells Captain Manners “that the observatory of the Collegio Romano is about to be furnished with a large refractor equatorially mounted. The refractor will have 9 inches aperture, and a focal length of 14 French feet.” There is only a little hesitation at present as to the best mode of mounting this telescope.

Observations Héliothermiques, par Sig. Secchi.

(*Comptes Rendus*, Oct. 26, 1852.)

Since the date of the preceding communication, Sig. Secchi has made the following interesting experiments on the heat emitted by different parts of the solar disc. It appeared from the former experiments that the heat increased from the margin of the solar disc to the centre; but there was this peculiarity, that when it was measured in the direction of the axis of the sun's rotation, it attained its maximum intensity at a point situate about 3' above the centre. At the time when the former experiments were made, the projection of the sun's equator upon his disc passed above his centre, at a distance agreeing almost exactly with the position of maximum temperature; whence the conclusion naturally suggested itself to Sig. Secchi, that the equatorial regions of the sun are intrinsically hotter than the other parts of his surface. He justly remarked, that if this were true, it ought to follow that in the month of June, when the nodes of the solar equator pass through the earth, the upper and lower hemispheres should appear equally heated; and on the other hand, in the month of September, when the projection of the solar equator attained its greatest depression, the point of maximum temperature should fall *below* the centre of the disc. Experiments similar to those previously undertaken by him have served to confirm this view of the subject. “In the month of August the upper hemisphere appeared a little hotter than the